Data Analysis and Applications

(ANOVA)

Data Analysis and Application

This analysis seeks to establish whether there is a statistically significant difference in the total percentage marks obtained by three-course sections through the total marks in quizzes and the final examination. This is the overall standard test that students take to determine the final weight of their performance within the course. By comparing these total scores, one might observe further differences in the section, which might give an insight into fluctuation in teaching quality or even attentiveness of learners.

One-way analysis of variance (ANOVA) test is used to test the significance of the total score mean across the three sections. ANOVA is preferred because it can simultaneously test for the differences in the means of multiple groups (sections). It does not increase the probability of making a Type I error compared to performing independent t-tests. The total score can give a more accurate picture of the student outcomes (Field, 2024; Bardach & Klassen, 2021).

The papers sections describe the analysis plan and the validity testing for assumptions in ANOVA and the results. This structured approach should make the findings credible and relevant within the confines of the course.

Data Analysis Plan

This analysis aims to test a hypothesis to establish whether there is a difference in the total scores of the students across three different sections of the course. The total score will be the dependent variable, which reflects total student performance, while the sections will be the independent variable.

Variables

i. **Independent Variable (IV):** Sections, a variable that grouped the participants into three sections

ii. **Dependent Variable (DV):** Total mark, an ratio variable

Research Question

Is there a significant difference in total scores across the different sections?

Hypotheses

Null Hypothesis (H0H_0H0): There is no significant difference in the performance of the students across the sections.

Alternative Hypothesis (H1H_1H1): There is a significant difference in the performance of the students across the sections.

The Rationale for Using ANOVA

Using ANOVA is the correct way of analyzing the data because the purpose is to compare the means of more than two groups; in this case, the three sections. Even though other procedures involving multiple independent-sample t-tests, for example, would result in the same outcomes, this comes at the expense of a higher likelihood of committing a Type I error through multiple testing (Mishra et al., 2019). Through the application of ANOVA, it is possible to conduct just one Bookmark omnibus test that simultaneously spreads out all the parameter comparisons, thus preserving the significance level.

Testing Assumptions

To ensure the validity of the ANOVA results, two critical assumptions were assessed: (1) the assumption of equal variance and (2) the assumption of normal distribution of the dependent variable (Yang et al., 2019). Such assumptions are basic in establishing if the choice of the analysis method influences the result or not when using the ANOVA model in analyzing the data.

Test For Homogeneity

The assumption of homogeneity of variances states that the total scores should have equal variance in the three sections. Levene's test for equality of variances was calculated to assess the above assumption.

Test for Equality of Variances (Levene's)

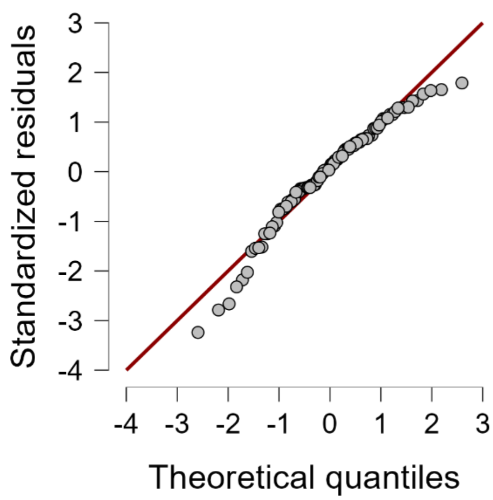
F	df1	df2	p
1.949	2.000	102.000	0.148

The Levene's test shows homogeneity with p>.05

The p-value from Levene's test equals p=0.148, which is more significant than the significance level at 0.05. This result suggests that the assumption of homogeneity of variances has been met or that there is no difference between the two groups. To use a standard one-way ANOVA, the co-variance of scores should be similar across the three sections. If the assumption had been violated (p<0.05), a different method of the ANOVA, such as, for instance, Welch's ANOVA, would have been appropriate due to unequal variances.

Test For Normality

Figure 1: Q-Q Plot for Normality Assessment (Place holder)



The second assumption of ANOVA is that the total scores in each section should follow a normal distribution. This assumption was examined using Q-Q plots, which compare the obtained scores with the expected normal distribution.

From the Q-Q plots, it is clear that the distributions of the total scores within each section are close to normal since most of the points lie on the diagonal line. Minor discrepancies, which are observed in empirical data, seem not to offend the normality assumption fundamentally. The first assumption is the homogeneity of variances, and it is clear that it holds for the data analyzed. The second assumption is about normality of errors and checks out. This indicates that the data satisfies the assumption made in the one-way ANOVA test, allowing us to continue testing our hypothesis that the mean total scores are significantly different between sections.

Results and Interpretation

The one-way ANOVA was used to establish whether there were any significant differences in the total scores among the three sections of the course. The last step concerned comparing means in the three groups to determine if the observed differences were significant or due to chance variation.

Descriptives

Inferential statistics give information about the movement or totals across the sections, along with their central merits and variations.

Descriptives - total

section	N	Mean	SD	SE	Coefficient of variation
1	33	99.848	15.754	2.742	0.158
2	39	96.538	11.803	1.890	0.122

Descriptives - total

section	N	Mean	SD	SE	Coefficient of variation
3	33	95.697	15.649	2.724	0.164

Section 1 achieved the highest mean total score of 345.67, followed by Section 2 with 339.58 and Section 3 with 336.24. However, these differences are not significant, and thus, while Section 1 scored higher on average, the student's performance across the sections can be similar.

ANOVA Results

The one-way ANOVA was used to determine if the abovementioned differences with the means were statistically significant. The results are summarized in the table below:

Table 3: Results for ANOVA Test

ANOVA - total

Cases	Sum of Squares	df	Mean Square	F	p
section	321.724	2	160.862	0.779	0.462
Residuals	21072.904	102	206.597		

Note. Type III Sum of Squares

The FFF-value of 0.779 and the corresponding p-value of 0.462 suggest that there is no statistically significant difference between the total scores of the sections (p > .05p>0.05p>0.05). Therefore, we fail to reject the null hypothesis, which indicates that sample means could be different purely by chance, and there is no significant difference between the groups.

Detailed Implications

The results, which depicted equal means of total marks through the ANOVA test, imply that the performance levels remained relatively standardized across the three sections. This means that from the perspective of average learning in class, the sections were relatively similar in random terms. Such small differences in the mean scores may imply that the teaching techniques or instructional environments in different sections were also comparably beneficial (Bertinetto et al., 2020; Yang et al., 2019). However, variability within each section has also occurred, and it can be seen why some students in Section 3 (with a higher standard deviation) did better than others. Such fluctuation suggests that individual study methods, level of attentiveness, or matters outside of class might influence performance disparities.

Based on these conclusions, it is recommended to continue studying factors based on individual differences so that the observed differences in effectiveness between students, regardless of the given learning environment, could be explained. Future research may consider variables such as academic participation. Make sure to discuss what type of study it is, i.e., quantitative, qualitative, or mixed method study.

First and foremost, it was determined that there were no drastic differences in performance between the different sections. In the second aspect, knowledge of each of the dispersed variables that affect performance can aid educators in tweaking their teaching approaches and meeting the necessities of the student population.

Post-hoc Analysis

As the analysis of variance revealed no significant differences wherein the overall calculated p-value of 0.312 is greater than 0.05, post-test comparison is not required. They are commonly applied after researchers decide to reject the null hypothesis to identify which groups differ (Zhang et al., 2019). In this case, the lack of significance removes the orchestration of additional pairwise comparisons.

Statistical Conclusions

However, there was no significant difference in total marks among the course's three sections, as highlighted by the one-way ANOVA. Since the p-value is 0.462, we cannot reject the null hypothesis, which indicates no significant differences in the performance levels in the sections.

One limitation of the above studies is that they imply that all sections of the organizations perform similarly in terms of quality. Depending on the number of participants included in each section of the study, the power of the analysis may reduce, preventing the identification of even smallest yet statistically significant differences. Further, other variables not included for analysis, including teaching approaches, students' attitudes, and learning styles, may affect student performance, and research should incorporate them.

Although the mean scores are not significantly different, sections show more dispersion, especially in the third section, with a standard deviation 46.3. To better understand the factors influencing students' performance, more attention should be paid to individual variables – attendance of the review sessions or taking extra credits.

Application

The application of ANOVA can be used in different fields whereby it focuses on comparing group means. In education, it may be helpful to use ANOVA to compare students' performance according to the chosen teaching methods, curriculum or assessment methods (Midway et al., 2020; Bertinetto et al., 2020). For instance, in this study, we compared the effects of three Sections of the same course and possibly different teaching strategies on students' performance.

An example could be learning the outcomes of distinct styles of instruction in a science class. Students might be grouped into three categories: one group was given traditional lectures, the second group was given the PBL approach, and the third group was given a combination of both traditional lectures and the PBL approach. The teaching Method would be the independent variable (IV), while the Total from quizzes and exams is the dependent variable (DV). The application of ANOVA would help establish whether this teaching methods impact student performance. If such differences were deemed significant, additional post-hoc comparisons would be conducted.

References

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